XAFS at the PNC-CAT Undulator Beamline

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Pacific Northwest Consortium-Collaborative Access Team (PNC-CAT)

Three institutions have taken the lead in forming and operating the CAT:
- University of Washington
- Simon Fraser University
- Pacific Northwest National Laboratory

Other affiliated institutions include:
- Washington State University
- University of Oregon
- University of Alberta
- University of Saskatchewan
- University of British Columbia
- Eastern Washington University

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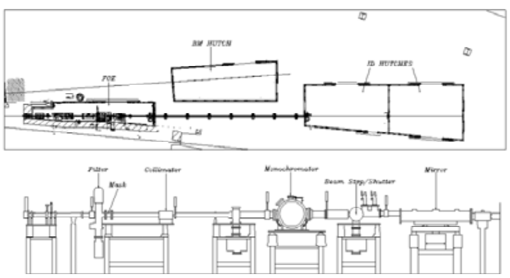
Project Status

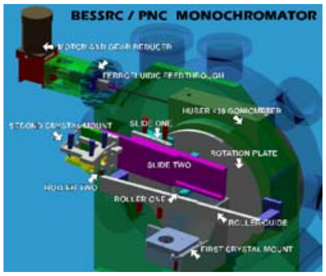
The five year beamline construction project will be completed in Feb. 2002. Both an undulator and bending magnet beamline are being built. The undulator line was declared operational in May 2000. The bending magnet line achieved first monochromatic light in Mar. 2000 and its commissioning continues. Work now is concentrating on bringing a full complement of endstation capabilities on-line. This paper describes the design and some intial results from the undulator beamline.

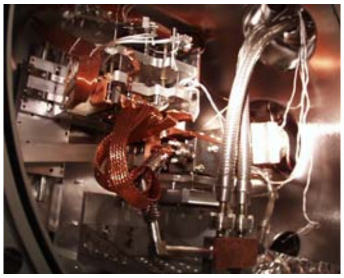
Beamline layout and hardware

The beamline consists of a fixed exit monochromator followed by a toroidal mirror. The experiments are housed in two experimental hutches. Most XAFS and micro-XAFS is carried out in the first hutch. UHV experiments are located in the second hutch.



Monochromator: A fixed exist design is used with liquid nitrogen cooled crystals. Si 111 and 311 crytals are mounted side-by-side to allow for rapid exchange by a simple translation of the monochromator housing. The first crystals are directly cooled and the second crystals are cooled through Cu braids. Rotation is provided by a Huber 430 goniometer and Heidenhain ROD 800 encoder. UHV conditons are achieved by mounting the rotation mechanism in a separate chamber.





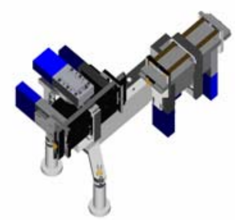
Toroidal focusing mirror: A bent cylindrical mirror can provide a focus at any position in the two experimental hutches. The focus is typically less than 0.5 mm, and contains up to 10^{13} ph./sec.

Endstation equipment: A full complement of equipment is available to support XAFS experiments.

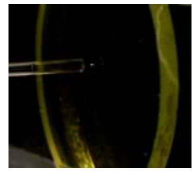
- 13 element Ge detector with DXP electronics
- Closed-cycle room-temperature loading refrigerator for temperatures to 15 K
- UHV surface XAFS chamber capable of in-situ MBE growth
- kappa and 8-circl psi diffractometers for DAFS studies
- High-repetition rate laser for time resolved studies
- tapered capillary and K-B mirror focusing for micro-XAFS (see next panel)
- Diamond phase-plate for MCD studies

Microfocusing

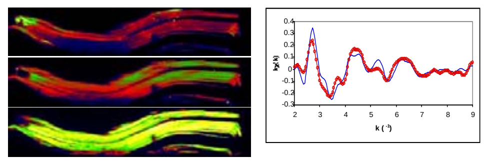
Two **Kirkpatrick-Baez** mirror systems have been built. The long set shown below focuses to 3 μm. A shorter version focuses to about 1 μm. Both are based on a design developed by CARS-CAT. A combination of a trapezoidal mirror shape and unequal bending moments gives an accurate elliptical bend.



Tapered capillaries concentrate the x-ray beam by passing it through a gradually tapering glass capillary. Typical inlet dimensions are 150 μm, and the outlets vary from 0.5 to 2 μm depending on the application. The figure shows the capillary outlet striking a fluorescent screen. The outer diameter of the capillary is about 200 μm.

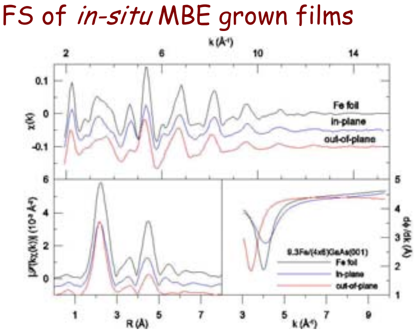


Cs absorption in Hanford site mica



Left: cross-sectional views of the Cs (top), Mn (middle) and K (bottom) concentrations in a biotite mica flake after exposure to a dilute solution of Cs. The image size is 780 x 170 μm. The Cs typically accumulates in weathered regions near the edge. Left: XAFS for the Mn edge in the high and low Cs regions

XAFS of *in-situ* MBE grown films



Fe K-edge fluorescence XAFS interference functions, k-weighted Fourier transform magnitudes and beating analysis (derivatives of phase in inverse transform of the first peak) for 9.3ML of Fe on (4x6) reconstructed GaAs(001) examined *in-situ* with the X-ray polarization in and out of the plane of the substrate. Transmission data for Fe foil are also shown for comparison.

Imaging and XAFS in a Diamond Micro-Reactor Cell

Fulton, J. L., Hoffmann, M. M., Darab, J. G., **Chemistry of Materials**, (2000), submitted.